

CLAIMS:

1. A vehicular steering control apparatus, characterized by comprising:
a steering input unit that is operated by a driver;
an automatic steering unit that automatically steers steerable wheels relative to
the steering input unit; and

a steering assist force generation unit that generates a steering assist force,
wherein

steering control performed by at least one of the automatic steering unit and the
steering assist force generation unit is so changed as to damp fluctuations in an operational
force required of the driver which result from inversion of an actual turning direction of the
steerable wheels, if it is determined that the turning direction is inverted through the
automatic steering.

2. The vehicular steering control apparatus according to claim 1, wherein
a steering torque is detected,
a target steering assist force is calculated on the basis of the steering torque, and
the steering assist force generation unit is controlled at least on the basis of the
target steering assist force.

3. The vehicular steering control apparatus according to claim 1 or 2,
wherein

a running state of a vehicle is estimated,
a target automatic steering amount for stabilizing the running state of the vehicle
by turning the steerable wheels is calculated if the running state of the vehicle is unstable,
and
the automatic steering unit is controlled at least on the basis of the target
automatic steering amount.

**4. The vehicular steering control apparatus according to any one of claims 1
to 3, wherein**

a steering assist force generated by the steering assist force generation unit is
increased in comparison with a case where an actual turning direction of the steerable
wheels that are turned through the automatic steering is not inverted, if it is determined that

the turning direction is inverted.

5. The vehicular steering control apparatus according to claim 4, wherein
an inversion time zone in which the turning direction is inverted is estimated,
and

a steering assist force generated by the steering assist force generation unit is
increased in the inversion time zone.

6. The vehicular steering control apparatus according to claim 5, wherein
the inversion time zone is estimated as a time zone including a period around a
time when the turning direction is actually inverted.

7. The vehicular steering control apparatus according to claim 5 or 6,
wherein

a time when an operational speed of the steering input unit and a turning speed
of the steerable wheels that are turned through automatic steering are equal in magnitude
and opposed in sign on the assumption that either a left-turn direction or a right-turn
direction is a positive direction is estimated as the time when the turning direction is
actually inverted.

8. The vehicular steering control apparatus according to any one of claims 5
to 7, wherein

a steering assist force generated by the steering assist force generation unit is
increased by detecting a steering torque and calculating a target steering assist force such
that a ratio of the target steering assist force to a steering torque becomes larger in the
inversion time zone than during a normal state.

9. The vehicular steering control apparatus according to any one of claims 5
to 8, wherein

a running state of the vehicle is estimated,
a target automatic steering amount for stabilizing the running state of the vehicle
by turning the steerable wheels is calculated if the degree of instability in the running state
of the vehicle is high,
the automatic steering unit is controlled at least on the basis of the target

automatic steering amount,

a change in the target automatic steering amount is predicted, and

an inversion time zone is estimated on the basis of the predicted change in the target automatic steering amount and an actual change in the target automatic steering amount.

10. The vehicular steering control apparatus according to any one of claims 1 to 3, wherein

an automatic steering amount of the steerable wheels that are steered by the automatic steering unit is reduced so as to prevent an actual turning direction of the steerable wheels that are turned through the automatic steering from being inverted, if it is determined that the turning direction is being inverted.

11. The vehicular steering control apparatus according to claim 10, wherein

an amount of reduction of an automatic steering amount of the steerable wheels that are steered by the automatic steering unit is reduced in comparison with a case where the degree of instability in the running state of the vehicle is low, if the degree of instability in the running state of the vehicle is high.

12. The vehicular steering control apparatus according to claim 10, wherein

the automatic steering amount of the steerable wheels that are steered by the automatic steering unit is not reduced if the degree of instability in the running state of the vehicle is high.

13. The vehicular steering control apparatus according to claim 1, wherein

a running state of the vehicle is estimated,

a target automatic steering amount for stabilizing the running state of the vehicle by turning the steerable wheels is calculated if the degree of instability in the running state of the vehicle is high,

the automatic steering unit is controlled at least on the basis of the target automatic steering amount, and

a determination is made on a situation in which an actual turning direction of the steerable wheels that are turned through automatic steering is inverted, on the basis of a relationship between a sign of a change rate of a steering operation amount and a sign of a

sum of a change rate of the steering operation amount and a change rate of the target automatic steering amount.

14. The vehicular steering control apparatus according to claim 1, wherein
an automatic steering amount of the steerable wheels that are steered by the automatic steering unit is reduced by estimating a running state of the vehicle, calculating a target automatic steering amount for stabilizing the running state of the vehicle by turning the steerable wheels if the degree of instability in the running state of the vehicle is high, calculating a change rate of the target automatic steering amount on the basis of the target automatic steering amount, controlling the automatic steering unit at least on the basis of the change rate of the target automatic steering amount, and reducing the change rate of the target automatic steering amount.

15. The vehicular steering control apparatus according to claim 14, wherein
the change rate of the target automatic steering amount is reduced to a value that does not allow the steerable wheels to be turned.

16. A vehicular steering control apparatus, comprising:
a steering input unit that is operated by a driver;
an automatic steering unit that automatically steers steerable wheels relative to the steering input unit;
a steering assist force generation unit that generates a steering assist force; and
a controller that determines whether or not an actual turning direction is inverted through the automatic steering, and changes steering control performed by at least one of the automatic steering unit and the steering assist force generation unit in such a manner as to damp fluctuations in an operational force required of the driver which result from inversion of the turning direction of the steerable wheels, if it is determined that the turning direction is inverted through the automatic steering.

17. The vehicular steering control apparatus according to claim 16, wherein
the controller increases a steering assist force generated by the steering assist force generation unit in comparison with a case where an actual turning direction of the steerable wheels that are turned through the automatic steering is not inverted, if it is determined that the turning direction is inverted.

18. The vehicular steering control apparatus according to claim 16, wherein
the controller reduces an automatic steering amount of the steerable wheels that
are steered by the automatic steering unit so as to prevent an actual turning direction of the
steerable wheels that are turned through the automatic steering from being inverted, if it is
determined that the turning direction is being inverted.

19. The vehicular steering control apparatus according to claim 18, wherein
the automatic steering unit automatically steers the steerable wheels so as to
stabilize a running state of the vehicle, and the controller reduces an amount of reduction
of an automatic steering amount of the steerable wheels that are steered by the automatic
steering unit in comparison with a case where the degree of instability in the running state
of the vehicle is low, if the degree of instability in the running state of the vehicle is high.